Space Weather Technical Forecast

Issued on Monday 10 February 2025 at 01:12 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Increasing Chance of M-class flares (R1-R2; Minor-Moderate radio blackouts). G1/Minor storms likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with C-class flares in the last 24 hours.

There are currently ten active regions on the Earth-facing disc. A cluster of entwined regions exists in the northwest quadrant, containing AR3978, AR3981 and AR3984. These three regions continue to show slow decay. The largest and most complex region is AR3981. Further reorganisation of the intermediate spots was observed. The other regions within this cluster are close together and rather ill-defined with respect to their boundaries and appear magnetically interconnected. Remaining regions on the disc are relatively small and simple. A new unnumbered region has recently rotated into view across the southeast limb.

No significant Earth directed Coronal Mass Ejections (CMEs) were observed from available imagery.

Solar Wind / Geomagnetic Activity: Solar winds were initially at slow-ambient levels around 350km/s before steadily increasing to reach elevated levels by 09/1800 UTC peaking at 637 km/s at 08/2333 UTC. The Interplanetary Magnetic Field, Bt, was initially moderate, around 15nT with a steady rising trend to high, peaking at 22nT at 09/1136 UTC. Levels currently remain at mostly Moderate levels. The north-south component, Bz, was initially largely moderately positive with the peak of 16nT at 09/1054 UTC, before turning mostly moderately southwards around 08/1300 UTC and dipping to -17nT at 091308 UTC. The phi angle was initially positive (away from the Sun) but began to change to negative (towards the Sun) from around 09/0550 UTC, due to an initial connection to CH13/-. Geomagnetic activity was Quiet (Kp 1-2) to start the period, becoming Active (Kp 4) later in the UTC day.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 remained at background levels.

High energy electron flux (greater than 2MeV) at GOES16 was at mostly background levels with a peak of 334 pppc at 09/1320 UTC. The associated 24-hour fluence persisted below the Active threshold on a recently rising trend, recording 2.96e6 integrated pfu at 10/0000UTC.

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Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate solar activity is likely with a slight chance of an X-class flare, primarily from the cluster of regions in the northwest, currently the greatest risk is from AR3981, especially during the next couple of days, before it rotates over the northwest limb, soon to be replaced by further sunspots rotating over the eastern limb.

Solar Wind / Geomagnetic Activity: There remains a slight chance of two glancing coronal mass ejections during Days 1 or 2 (10-11 Feb). SSolar winds are likely to be at elevated to strong levels due to connection to a HSS from CH13/-, as a result. A subsequent connection to CH14/- is then forecast to follow from Day 2 (11 Feb) onwards to maintain these enhanced levels.

Unsettled to Active (Kp 3-4) geomagnetic activity with G1/Minor storm (Kp 5) intervals likely and a slight chance of G2/Moderate storm intervals (Kp 6). Through the rest of the guidance period activity likely continuing at Active to G1/Minor storm levels, with the combined risk of the CME arrival on Days 1 and 2 (10/11 Feb) and a subsequent potential connection to a HSS from CH14/- by Day 3 (12 Feb).

Energetic Particles / Solar Radiation: There is a slight chance of S1/Minor radiation storm events as the cluster of sunspots in the northwest are now in a good position to connect with Earth, should there be further large flares. High energy electron flux observed at GOES16 is expected to be at background to moderate levels, with a probable rising trend and may reach High levels at times during the daily diurnal maximum. The corresponding 24 hour fluence is likely to continue rising and may threaten to breach the Active threshold later in the guidance period.

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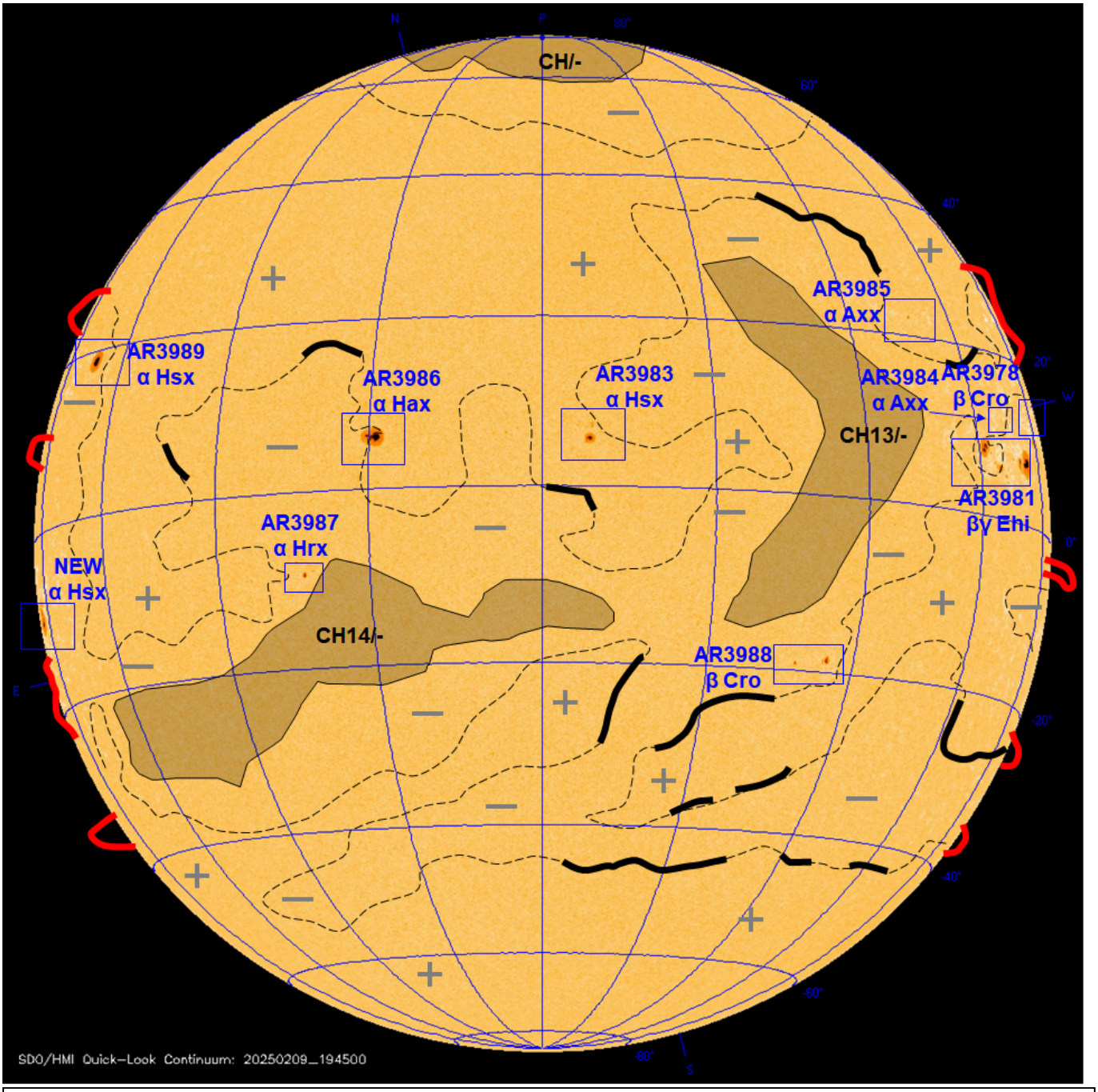
Figure 1: Solar Synoptic Map Valid 09/2000 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There is a slight chance of up to two glancing blows from faint CMEs associated with two M7 flares on 06/07 Feb, which may arrive at Earth late on Day 1 (10 Feb) and into the early hours of Day 2 (11 Feb). A third slow CME left the Sun around 08/0930 UTC in association with the M2.0 flare from AR3981, given its slow speeds, it is currently thought that it will get absorbed into the HSS with little defined impact to Earth.

Solar winds are now at elevated levels due to a connection to the high speed stream from CH13/-. This feature appears to be larger and more intense compared to the previous rotation, when speeds reached around 450 km/s. On this rotation solar winds are likely to continue at elevated to strong levels (550-650 km/s), in line with MOSWOC Enlil expectations. However Enlil was too early in its onset of the HSS arrival at Earth. A connection to a HSS from CH14/-, will then follow by Day 2 or 3 (11/12 Feb) again a recurring feature with solar winds remaining Elevated to Strong.

Unsettled to Active (Kp 3-4) geomagnetic activity to start the guidance period with G1/Minor storm (Kp 5) intervals likely and a slight chance of G2/Moderate storm intervals (Kp 6). The highest risk of G2/Moderate Storms is probably sometime in the next 24 hours and perhaps again around Day 3 (12 Feb) when Earth connects to CH14/-. Through much of the period activity likely continuing at Active to G1/Minor storm levels, with the potential combined risk of the CME arrivals during Days 1 and 2 (10/11 Feb), complicating the forecast somewhat.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	70	60	70	50
Strong	G3	No	20	5	10	5
Severe	G4	No	5	1	1	0
Extreme	G5	No	1	1	1	0

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
07/0200	Partial	AR3981	NW	300	10/2100 +/-12 hours	Low confidence.
07/2100	Partial	AR3981	NW	300	11/0000 +/-12 hours	Low confidence.

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Figure 2: MOSWOC Enlil output, showing the HSS onset too early compared to reality.

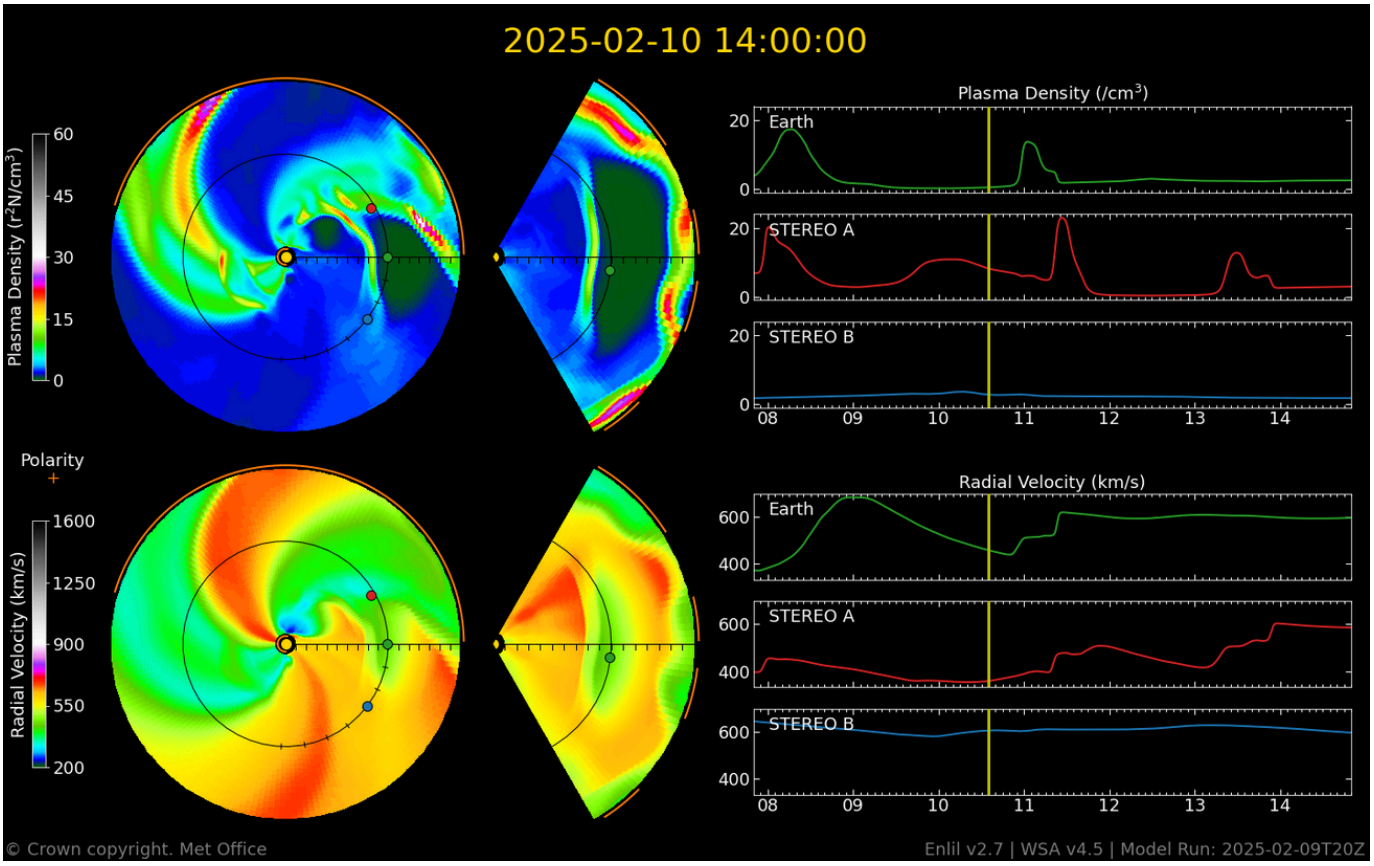

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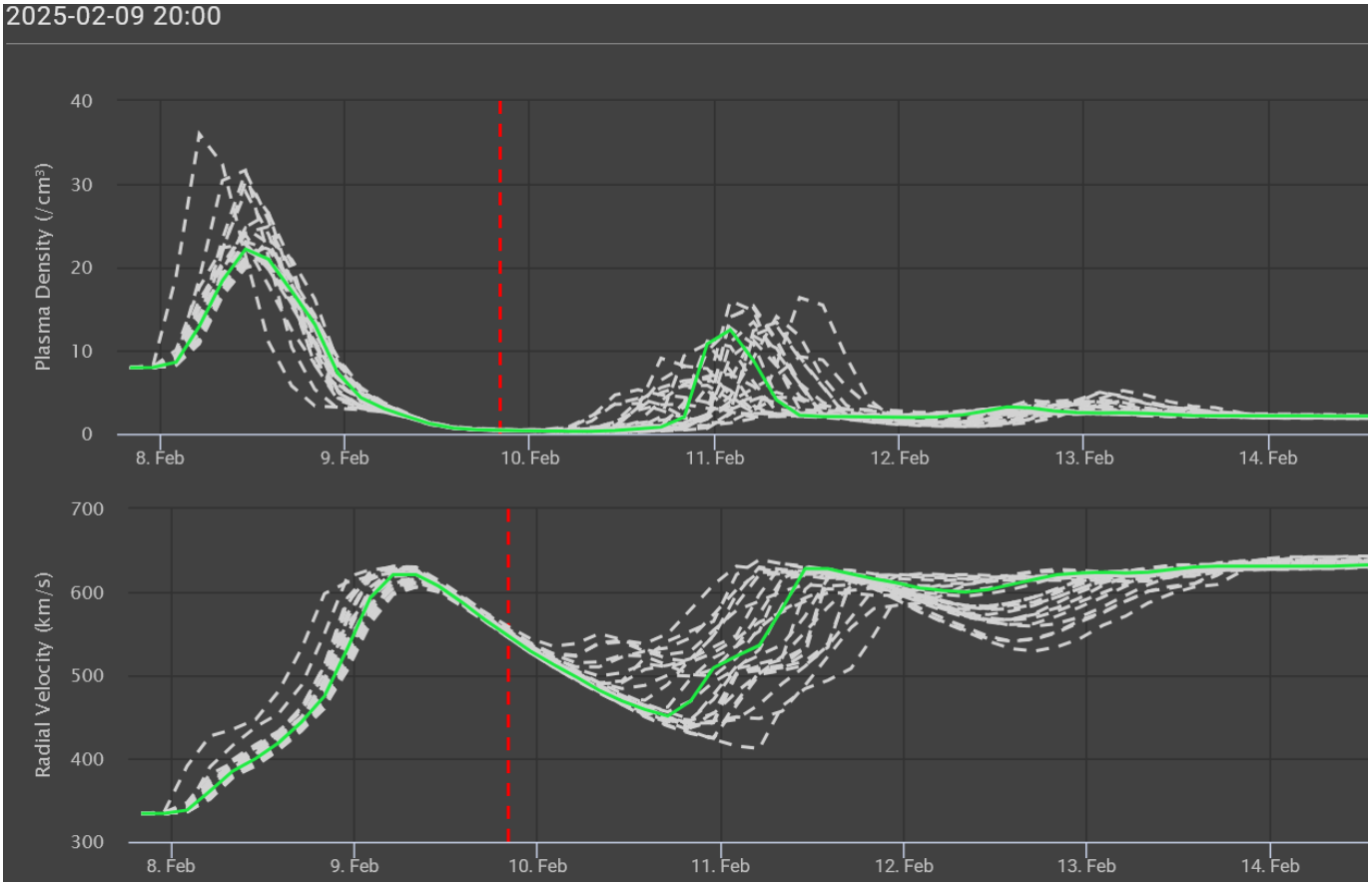
Figure 3: MOSWOC Ensemble data showing the spread of arrival times for a CME on 10/11 Feb.



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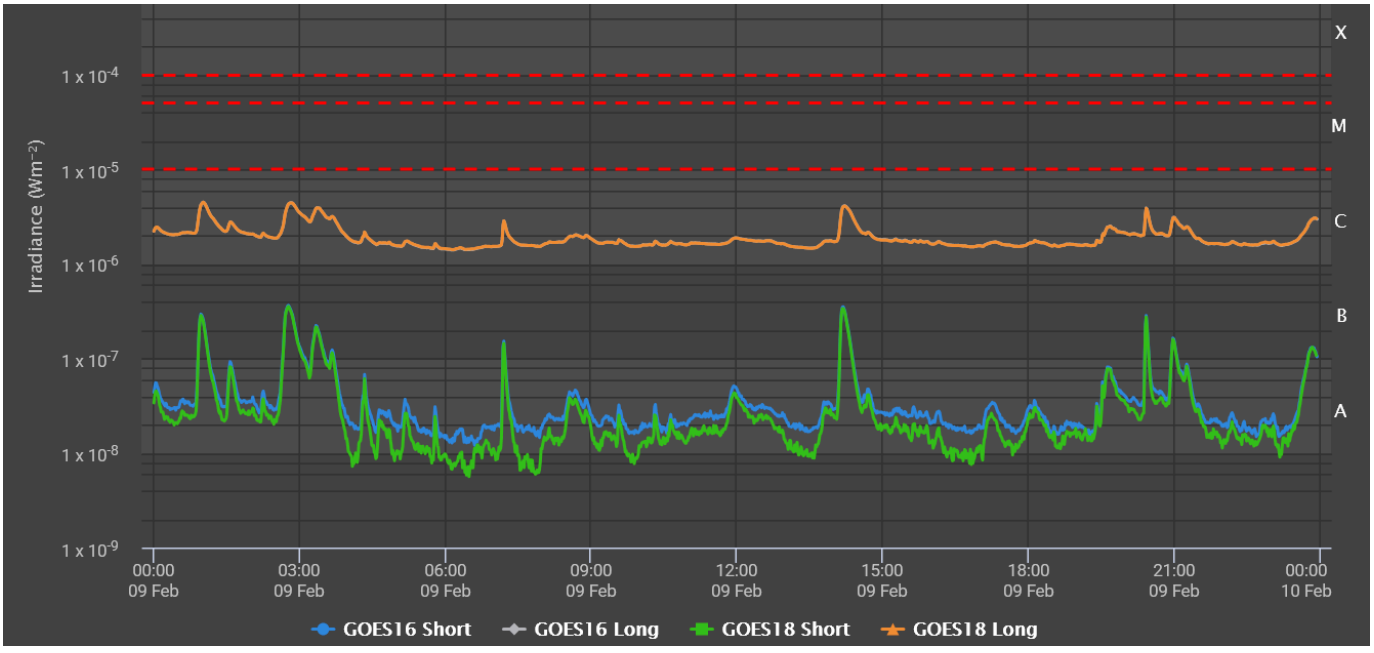
Radio Blackouts - X-Ray Flares

Ten active regions cover the Earth-facing disc. The complex of regions in the northwest quadrant, including AR3978, AR3981 and AR3984 show further slow decay. The largest and most complex region is AR3981. Remaining regions on the disc are relatively small and simple. A new unnumbered region has appeared in recent imagery on the southeast limb. This region shows significant magnetic looping and is likely to be a complex group, but more imagery is needed to diagnose this further. Visible plage on the southeast limb is also indicating further regions likely to rotate on to the Earth-facing disc in the next 24-48 hours.

Solar activity is low with a few C-class flares in the last 24 hours. There is an increasing chance of further M-class flares., with a slight chance of an isolated X-class flare. While AR3981 will begin to rotate off the western limb from the end of Day 1 (10 Feb), SDO/AIA 171 imagery shows notable looping around the eastern limb and combined with far-sided data suggests several complex regions are soon to appear. As a result the forecast probabilities of significant flares, in the table below, show a slight increase in probabilities from Day 3 (12 Feb).

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	40	40	60	70
Very Active	R3-R5 (X Class)	No	5	5	10	20

Figure 4: X-ray flux trace from GOES 16&18 over the last 24 hours.



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Solar Radiation Storms (High Energy Protons)

The northwestern cluster of sunspots, including AR3981, is in a increasingly favourable position to connect with Earth with potential to generate a response in proton flux (as measured at GEO) following any large flares. That said, none of the more notable flares have so far proven proton-rich, therefore the overall risk is remained at a slight chance of reaching above the S1/Minor radiation storm threshold throughout the period.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	5
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been at background to Moderate levels. The arrival of the High Speed stream (HSS) related to CH13/-, is likely to give an eventual significant response in charging of the Van-Allen belts. Possible CME arrivals in the interim complicate this picture, but overall mostly background to Moderate electron flux is expected until later in the period when high levels are more likely especially at diurnal peak.

The corresponding 24-hour fluence is expected to be mostly below the Active threshold during this guidance period, with a rising trend probable. MOSWOC REFM output shows levels below Active. However this is likely underforecasting the likely rise given the more marked appearance of CH13/- and probabilities of a breach are raised each day for the fluence alert to be activated.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	5	20	40	50
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	5	10

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Figure 5: High energy electron flux at GEO and Met Office REFM output.

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